



Concussion

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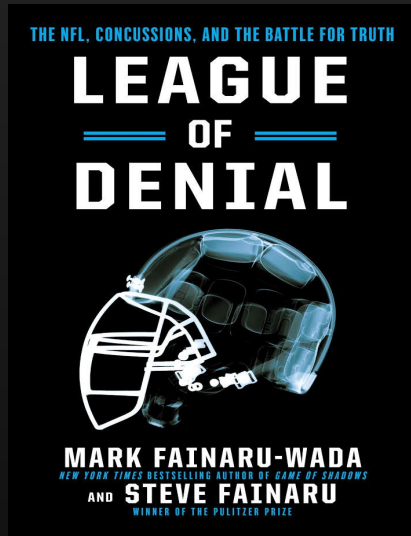
Jonny Diercks MS, ATC

Objectives

Understand	Understand the pathophysiology of concussion
Identify	Identify the risk factors for protracted recovery of concussion
Understand	Understand and be able to assess the most common vestibular and ocular motor impairments post concussion
Be	Be familiar with the indications for vestibular and exertion therapy
Have	Have a working knowledge of vestibular and exertion treatment progressions

NFL says regular-season concussions increased 18% in 2022

Kevin Seifert
ESPN Staff Writer
Feb 3, 2023



The Truth About Concussions

By [Samantha Costa](#), Staff Writer | Nov. 10
U.S. News and World Report

Repetitive hits, concussions, and a mother's long goodbye to youth football

By Julie DiCaro September 12
Washington Post

1 In 5 Teens Reports A Concussion Diagnosis

September 26, 2017 11:42 AM ET

NPR

GRETA JOCHEM



Playing Tackle Football Before 12 Is Tied to Brain Problems Later

By [KEN BELSON](#)
New York Times
SEPT. 19, 2017

Three or more concussions linked with worse brain function in later life

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UNIVERSITY OF OXFORD

True/False?

You must avoid all activities after a concussion.

To truly have a concussion, you must lose consciousness or “blackout”

The best helmet can prevent a concussion.

It is important to awaken a person post-concussion every 20 minutes, and shine a light in their eyes to check their status.

MRI/CT are necessary to diagnose a concussion.

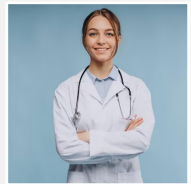
Epidemiology



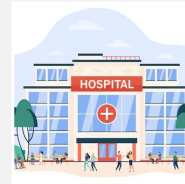
Up to 3.8 million
concussions per year in
sport or recreational
activities



Indirect cost – 60 billion per
year



1.365 million emergency
room visits



275,000 hospital stays

What can we do as medical professionals?

Recognize

Remove

Re-evaluate

Rest and Exercise

Rehabilitation

Refer

Recover

Return to Learn, Return to Sport

Reconsider

Residual effects and sequelae

Risk Reduction, Retirement Discussion

Recognize - What is a Concussion?

- Mild Traumatic Brain Injury
- A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head
- A disturbance of brain function related to neurometabolic dysfunction, rather than a structural brain injury
- Results in a constellation of physical, cognitive, emotional and sleep related symptoms
 - Symptoms may last for several minutes to days, weeks, months and even longer in some cases

Concussion

Thought to be one of the most challenging and complex injuries in sports medicine to diagnose, assess, and manage

The majority of sport related concussions occur without loss of consciousness or a frank neurological sign

Currently, there is no perfect test or marker that clinicians can rely on for immediate diagnosis in the sport environment

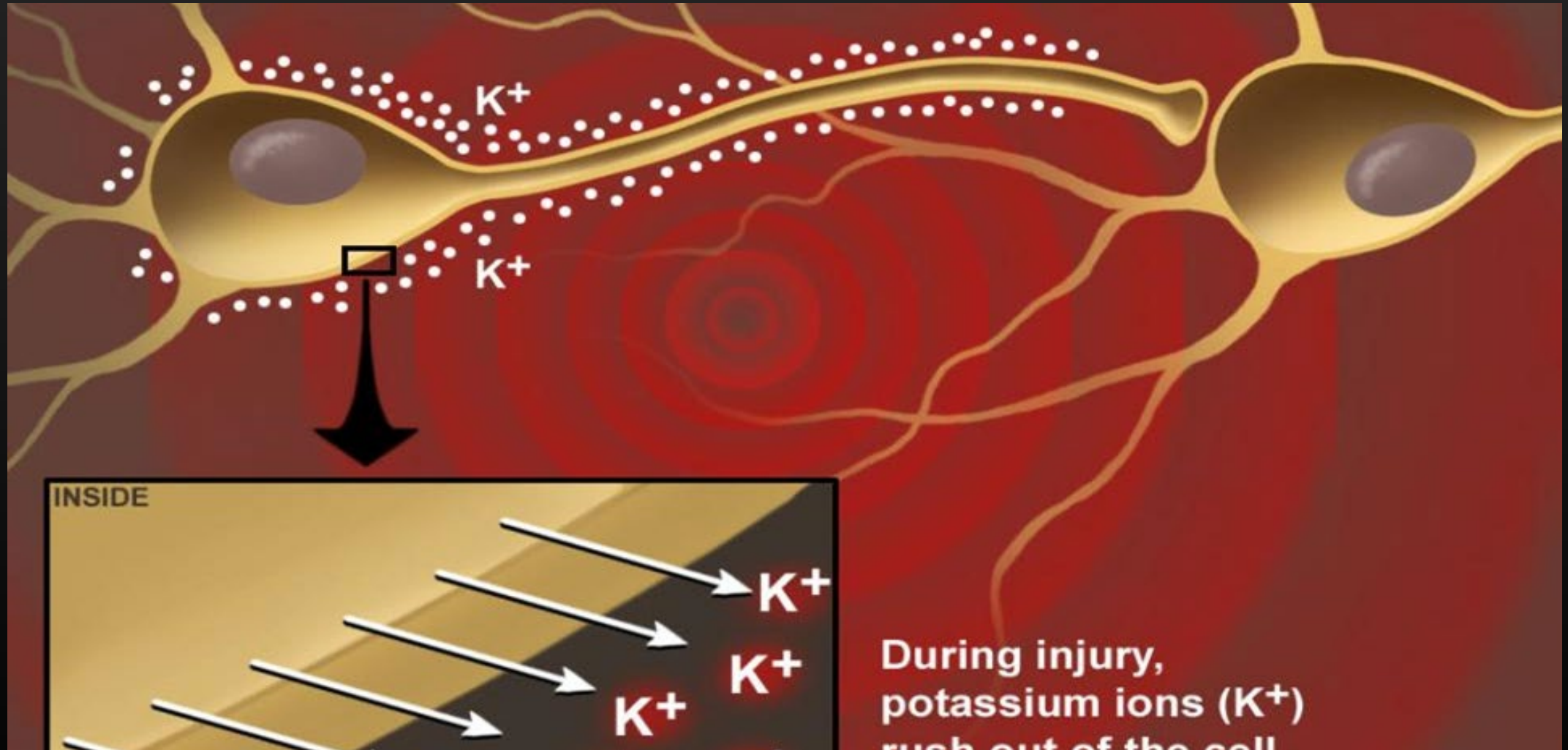
The Forces of Concussion Set Off a Series of Reactions

- Injury causes the neurons to stretch
 - Triggering a release of excitatory neurotransmitters (such as glutamate)
 - Which bind to NMDA receptors
 - Leads to further depolarization triggering
 - Efflux of Potassium (K⁺)
 - Influx of Calcium (Ca²⁺)
 - Resulting in **ion imbalance**
 - In an effort to restore ion balance, the **sodium potassium pump works overtime**
 - Sodium potassium pump requires increased ATP/glucose
 - **Demand for increased blood glucose**

Normal Neuron Function

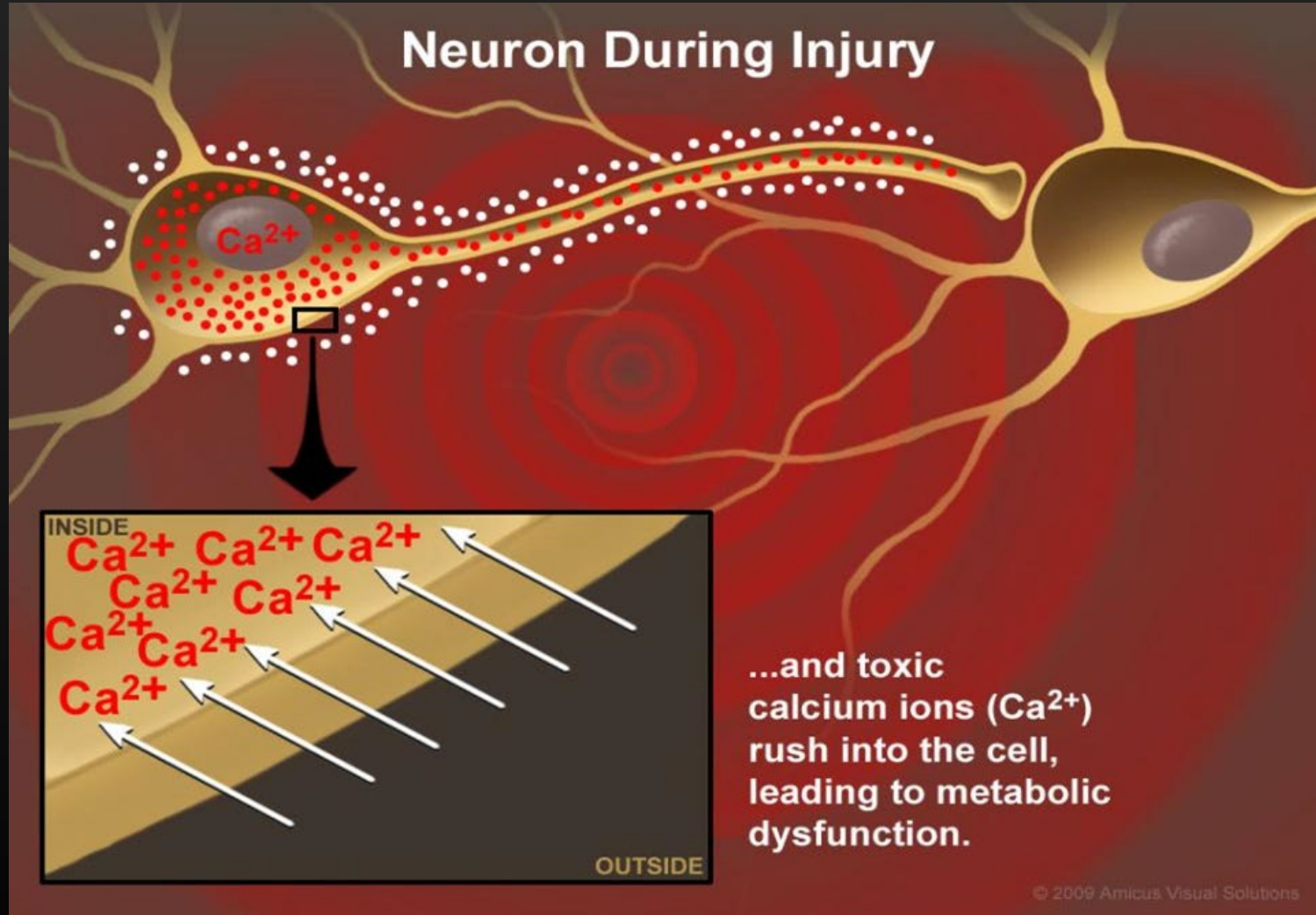
Neurotransmitters are released in an organized manner, triggering the next cell with a specific coded message





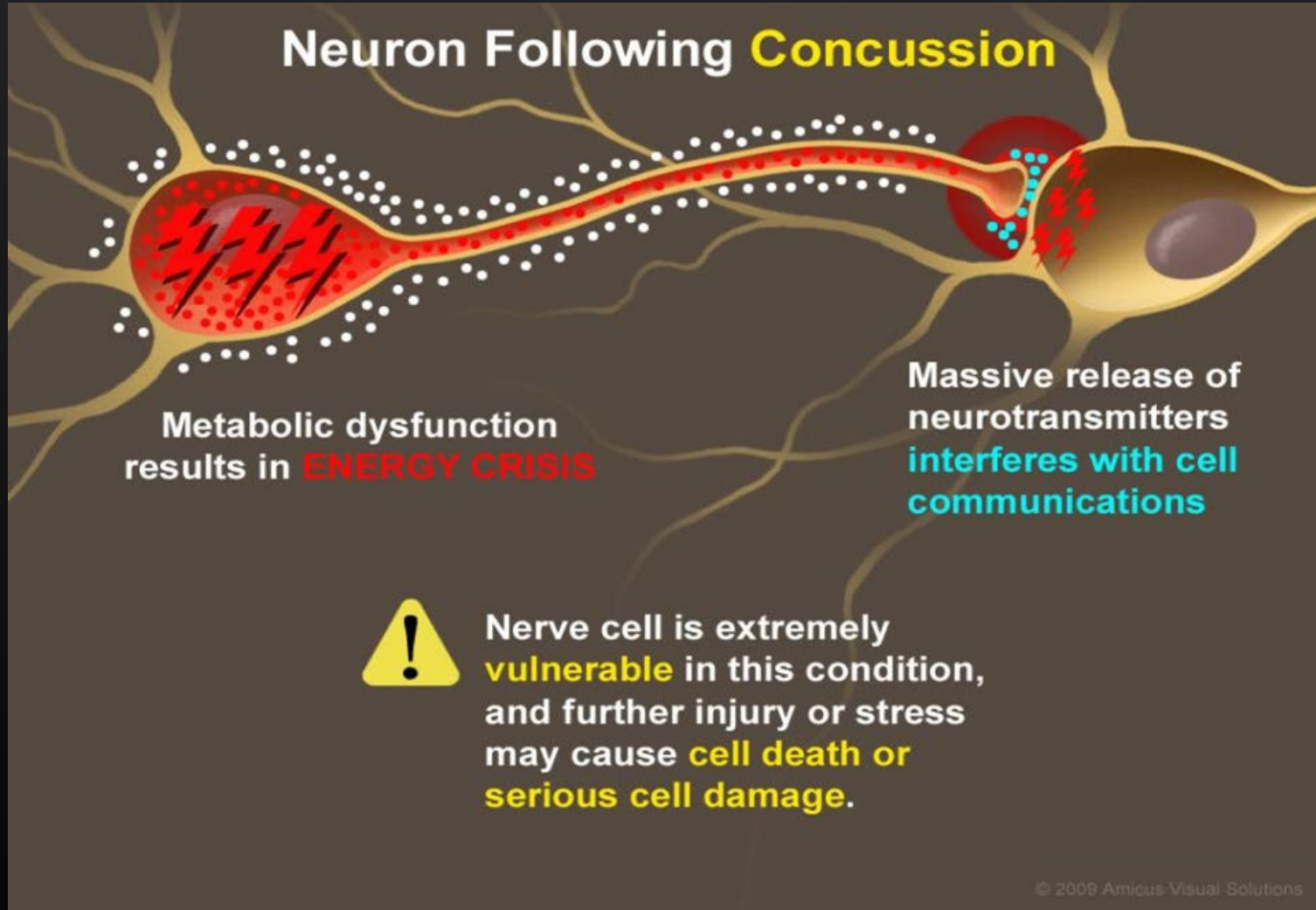
During injury,
potassium ions (K^+)
rush out of the cell

Neuron During Injury



...and toxic calcium ions (Ca^{2+}) rush into the cell, leading to metabolic dysfunction.

Neuron Following Concussion



Metabolic dysfunction
results in **ENERGY CRISIS**

Massive release of
neurotransmitters
**interferes with cell
communications**



Nerve cell is extremely
vulnerable in this condition,
and further injury or stress
may cause **cell death or
serious cell damage.**

Recovery of Concussion

80- 90% of concussions resolve in 10 – 14 days.

10-20% have a prolonged recovery – and can develop Post Concussion Syndrome.

Post Concussion Syndrome

- Post Concussion Syndrome Risk Factors
 - Factors that would pre-dispose athlete to requiring longer than 10-14 days to recover
 - Frequency and timing of concussion – either repeated injuries over time or injuries close together in time
 - Children/adolescents
 - Females
 - History of
 - migraine headaches
 - Depression or other mental health disorders
 - ADHD
 - Learning disabilities
 - Sleep disorders
 - Ocular motor disorder
 - Motion sickness

Rehabilitation

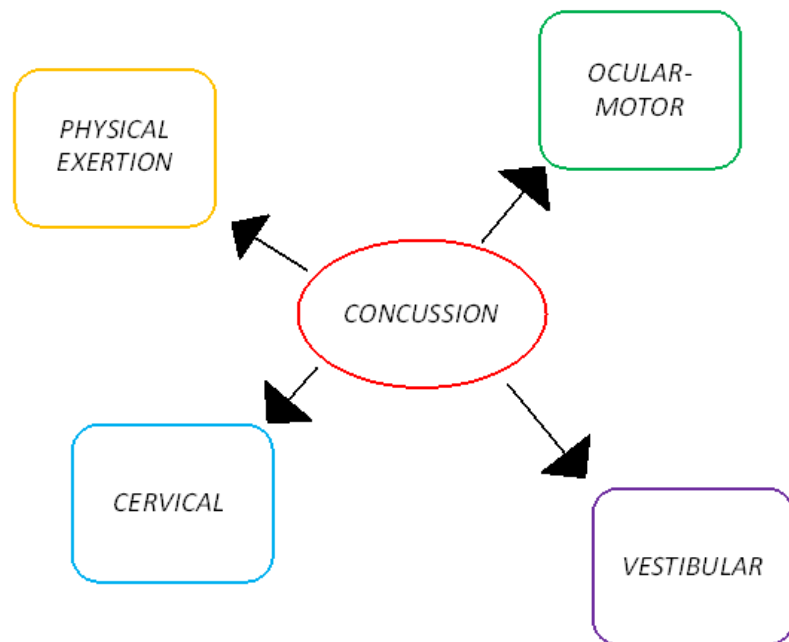
Rehabilitation has been shown to be effective for those whose symptoms have not resolved within typical timeframe

- 10 -14 days for adults
- 4 weeks for children

Research has supported treatments such as:

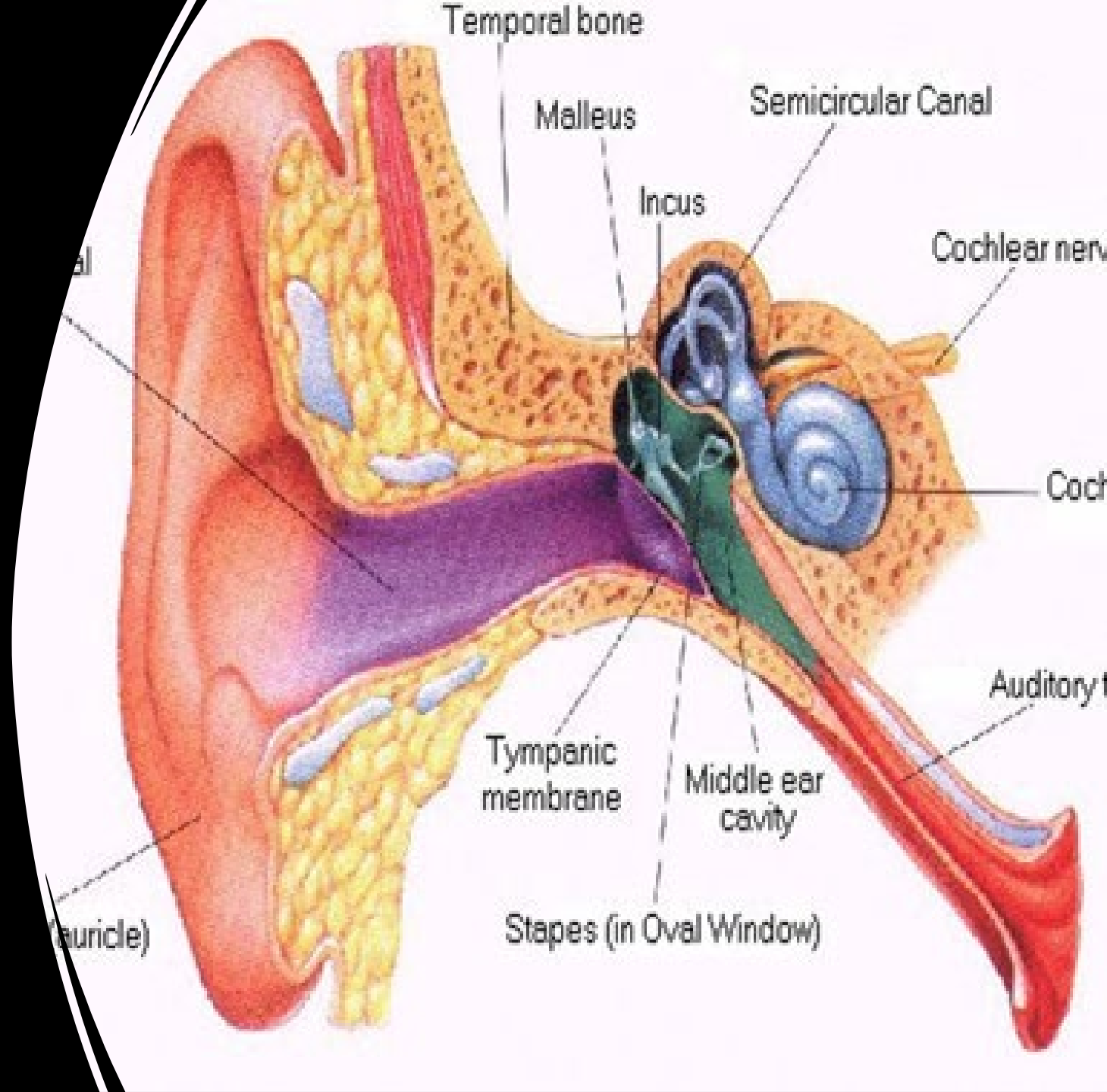
- Psychological interventions
- Vestibular rehabilitation
- Cervical spine management
- Guided physical exercise

Rehabilitation Role in Concussion Management



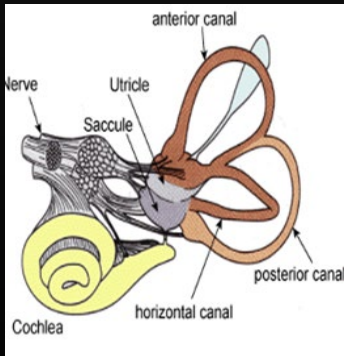
- “A combination of cervical and vestibular physiotherapy decreased time to medical clearance to return to sport in youth and young adults with persistent symptoms of dizziness, neck pain and/or headaches following a sport-related concussion.” Schneider, 2014

Vestibular Rehabilitation



Vestibular System

- One of three balance systems in body:
 - Vision
 - Somatosensory
 - Vestibular



Peripheral Vestibular System:

Semicircular canals
Otoliths: Utricle and Saccule
Vestibular Ganglia
Vestibular Nerve

Central Vestibular System:

Vestibular Nuclei
Cerebellum
Cortex
Thalamus



What Does the Vestibular System Do?

- Senses linear and angular speed
- Senses rotational movement of the head
- Senses linear movement of the head
- Senses head position in space



Vestibular System

Two Functional Units

Vestibulo-ocular system

Maintains visual stability during head movement

Impairment produces:

Dizziness

Visual instability

Vestibulo-spinal system

Maintains postural control

Impairment produces:

Poor balance

Balance System and Concussion

Balance impairments resolve quickly compared to other symptoms following a concussion (Catena, 2011).

Ability to utilize and process vestibular information needed for balance may be affected in concussed individuals (Guskewitz, 2001).

Objective balance impairments recover in most athletes by 3 -5 days post concussion (Mucha, 2014).

Cluster of Symptoms for Vestibulo-Ocular Impairments Post Concussion



Dizziness



Nausea



Balance Problems



Headache



Sensitivity to visual motion - busy environments etc.



Blurred vision (when moving head)

Review of the Literature

“61% of patients reported symptom provocation after at least 1 VOMS item.” (Mucha, 2014)

Almost 50% of athletes following a sport related concussion report dizziness (Kontos et al, 2012). Dizziness at the time of injury is a risk factor for prolonged recovery (Lau et al, 2011).

“A combination of cervical and vestibular physiotherapy decreased time to medical clearance to return to sport in youth and young adults with persistent symptoms of dizziness, neck pain and/or headaches following a sport related concussion.” (Schneider, 2014)

“Vestibular complaints are the most frequent sequelae of mTBI. Vestibular physical therapy has been established as the most important treatment modality for this group of patients.” (Gotshall, 2011)

Review of the Literature

Smooth Pursuit Impairment – 60%



Convergence Insufficiency – 55%



Accommodative Impairments – 65%



Ocular Misalignment – 55%



Saccadic Impairment – 30%

Vestibular Ocular Motor Screen

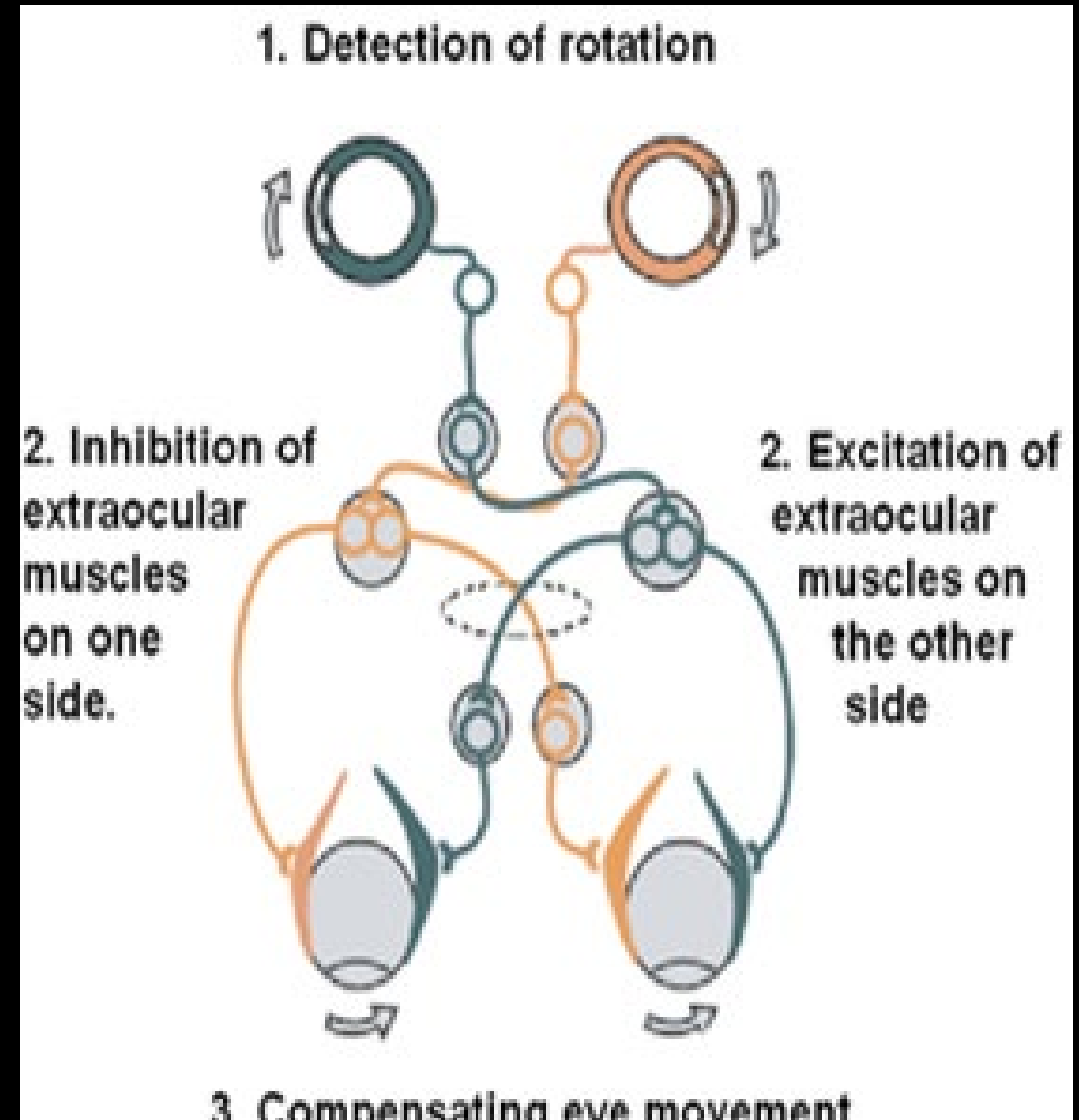
- Smooth pursuits
- Saccades
- Convergence
- VOR horizontal
- VOR vertical
- VOR cancellation (visual motion sensitivity)

VOMS -
screening tool
to indicate
need for a
referral to
vestibular and
ocular motor
rehabilitation

Has shown an
ability to
predict
concussed vs.
non concussed
individuals

VOR (Vestibular Ocular Reflex)

- Reflex that provides the ability to maintain focus on a stationary target while moving the head without loss of focus or dizziness
- *Stabilizes vision while head moves*
- Examples of use of VOR:
 - Walking - head moves 100 degrees/second
 - ADLs - head moves 120 degrees/second
 - Running - head moves 550 degrees/second
- Abnormal findings: blurry vision



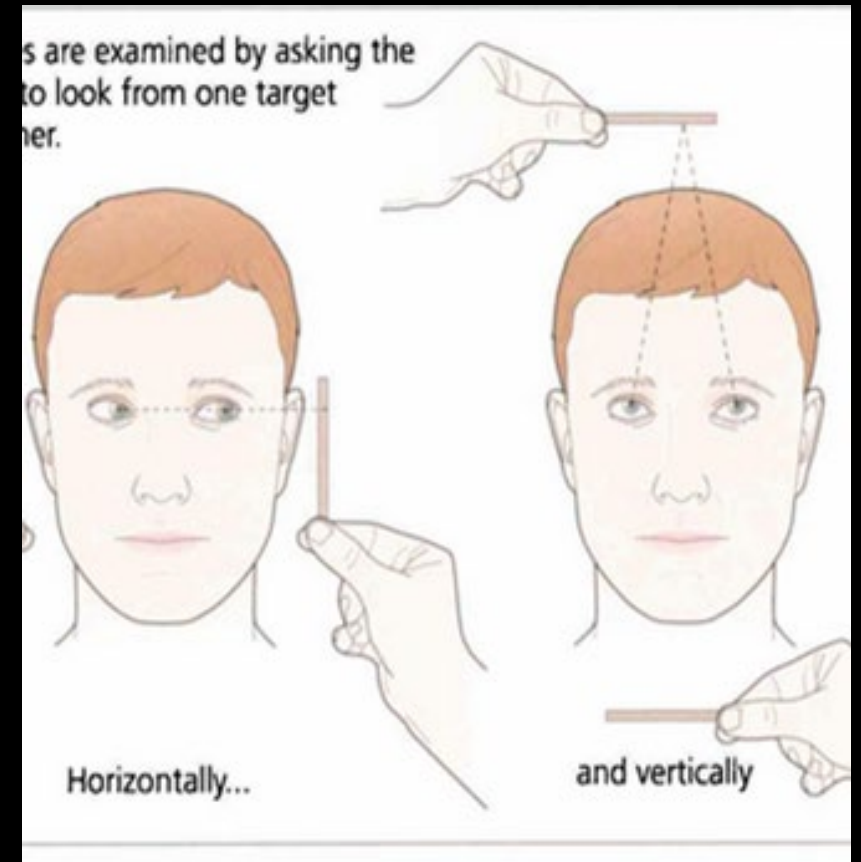
VOR Cancellation

- Increased awareness of normal visual motion
- This can be used to assess visual motion sensitivity
- Abnormal findings: Symptom provocation created by moving crowds, busy environments
- Ex: supermarket, school hallway, hockey game



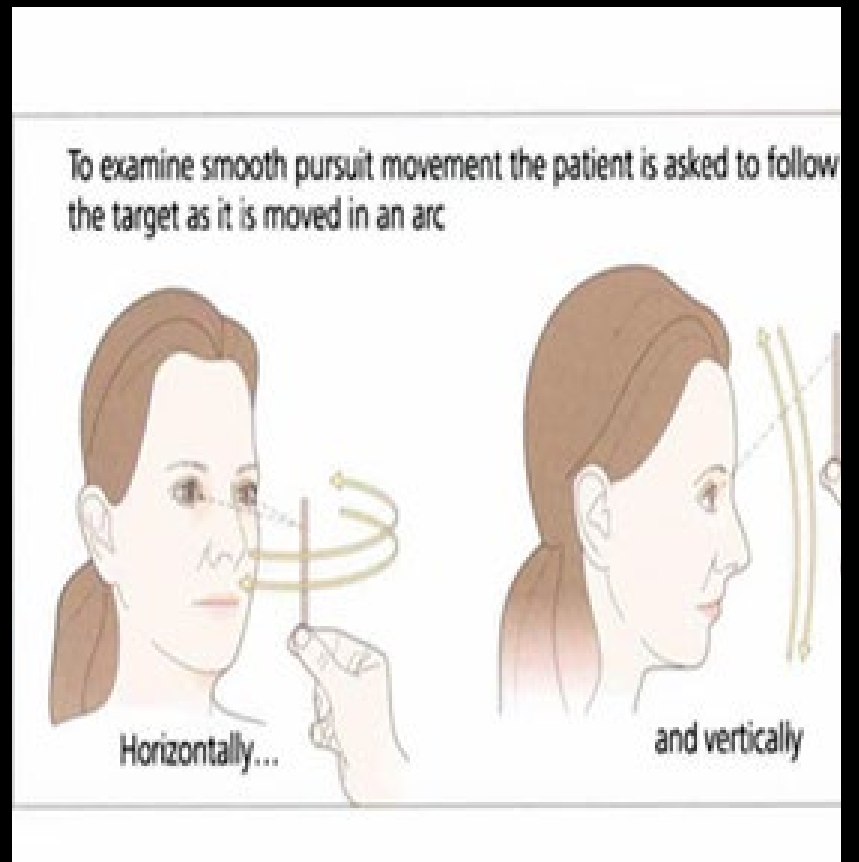
Saccades

- Function: ability to look at one target, and then quickly at another
- Abnormal findings
 - over / undershooting (cerebellar / brainstem lesion)
 - More than 3 saccades to get to target
 - Slow speed



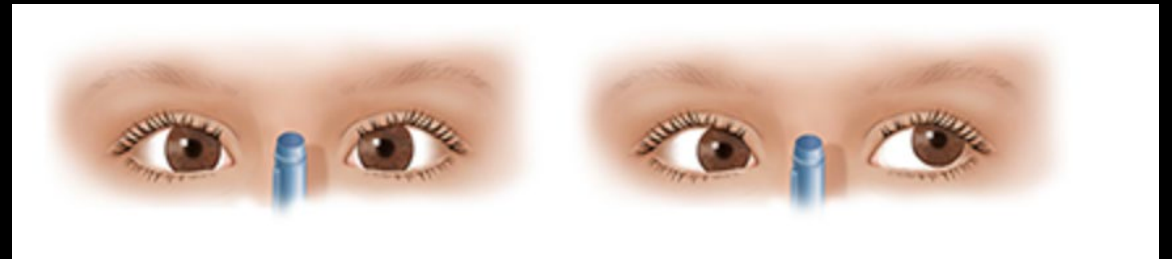
Smooth Pursuits

- Function: Ability to smoothly follow target with eyes
- Abnormal findings
 - Asymmetric eye movement
 - Saccadic movement/ not smooth movement while tracking (age is a factor)



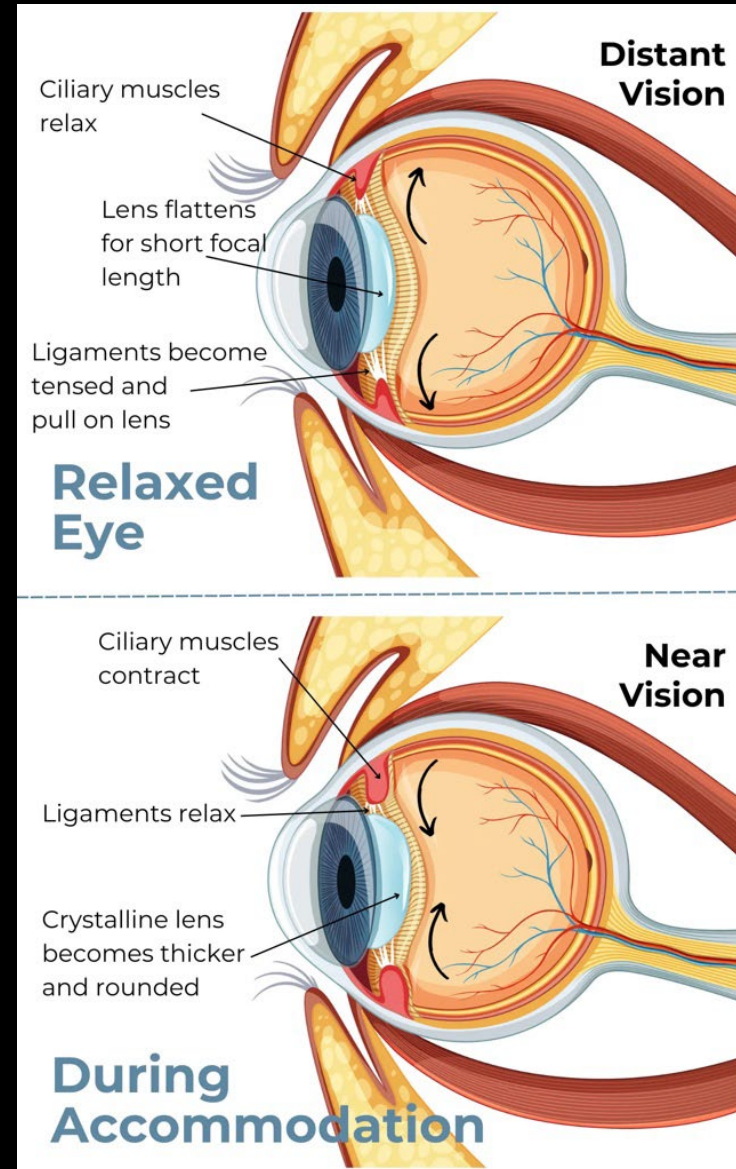
Convergence

- Ability of the eyes to turn inward toward each other to look at a close object like book, tablet, screen.
- Abnormal findings:
 - Eye(s) drift outward when looking at close object



Accommodation

- Eye's ability to adjust focus to see objects clearly at differing distances.
- Reflex that allows the eye to focus near to far
- Abnormal Findings: blurry vision



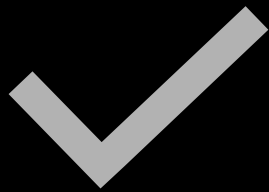
LAB!



Role Play Activity

- Athletic Trainer vs. athlete/family interaction regarding post concussive family member
- Athlete and family are scared and do not understand what happens to the brain after a concussion.
 - Explain to patient and family what happens after a concussion from a physiological standpoint.
 - Highlight the next steps after a concussion, and what the patient and his/her family can expect for care.

Vestibular Lab



VOMS practice



Vestibular testing/DVA



Vestibular treatment
progressions

VOMS Lab

- Designed for use with patients age 9-40.
- Abnormal findings or symptoms with any test may indicate dysfunction and should warrant a referral to a vestibular therapist.
- Record headache, dizziness, nausea and foginess prior to testing and after each test

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

VOR (Vestibular Ocular Reflex)

- 14 point font target in front of the patient in midline at a distance of 3 ft
- Horizontal and Vertical: Pt rotates head while maintaining focus on the target.
- Head moves 20 degrees to each side.
- Speed: 180 beats/minute.



VOR Cancellation

- Patient standing/sitting facing a busy area of the clinic.
- The patient holds arm outstretched and focuses on target.
- Maintaining focus on target, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left.
- Speed of rotation = 50 beats/min
- 5 repetitions are performed.



Saccades

- An examiner holds two single targets horizontally at a distance of 3 ft. from the patient
- The target is 1.5 ft. to the right and 1.5 ft. to the left of midline so that the patient must gaze 30 degrees to left and 30 degrees to the right.
- Patient to move their eyes as quickly as possible from point to point.
- 10 repetitions are performed



Smooth Pursuits

- Target at a distance of 3 ft. from the patient.
- Patient maintains focus on the target as the examiner moves the target smoothly in the horizontal direction 1.5 ft. to the right and 1.5 ft. to the left of midline.
- 2 repetitions are performed.
- The target is moving at 2 seconds to go fully from left to right.
- The test is repeated with the examiner moving the target smoothly and slowly in the vertical direction 1.5 ft. above and 1.5 ft. below midline.
- 2 complete repetitions up and down.



Convergence

- Patient focuses on a 14 point target at arm's length and slowly brings it toward the tip of their nose.
- Stop moving the target when two distinct images are seen or when the examiner observes an outward deviation of one eye.
- Blurring of the image is ignored.
- The distance in cm. between target and the tip of nose is measured and recorded.
- This is repeated a total of 3 times with measures recorded each time.
- Abnormal: Near Point of convergence ≥ 6 cm from the tip of the nose.



Accommodation

- Close one eye
 - Bring target towards eye
 - Indicate when the target becomes blurry.
 - Performed 1 time on each eye
 - Age matched norms



VOMS Lab – on your own

Convergence:

- Patient focuses on a 14 point target at arm’s length and slowly brings it toward the tip of their nose.
- Stop moving the target when two distinct images are seen or when the examiner observes an outward deviation of one eye.
- Blurring of the image is ignored.
- The distance in cm. between target and the tip of nose is measured and recorded.
- This is repeated a total of 3 times with measures recorded each time.
- Record: Headache, Dizziness, Nausea & Fogginess ratings after the test.
- Abnormal: Near Point of convergence ≥ 6 cm from the tip of the nose.

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- 2 complete repetitions up and down.

VOR x 1:

14 point font target in front of the patient in midline at a distance of 3 ft

Horizontal and Vertical: Pt rotates head while maintaining focus on the target.

Head moves 20 degrees to each side.

Speed: 180 beats/minute.

Record: Headache, Dizziness, Nausea and Fogginess ratings 10 sec after the test is completed.

VOR cancellation:

Patient standing/sitting facing a busy area of the clinic.

The patient holds arm outstretched and focuses on target.

Maintaining focus on target, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left.

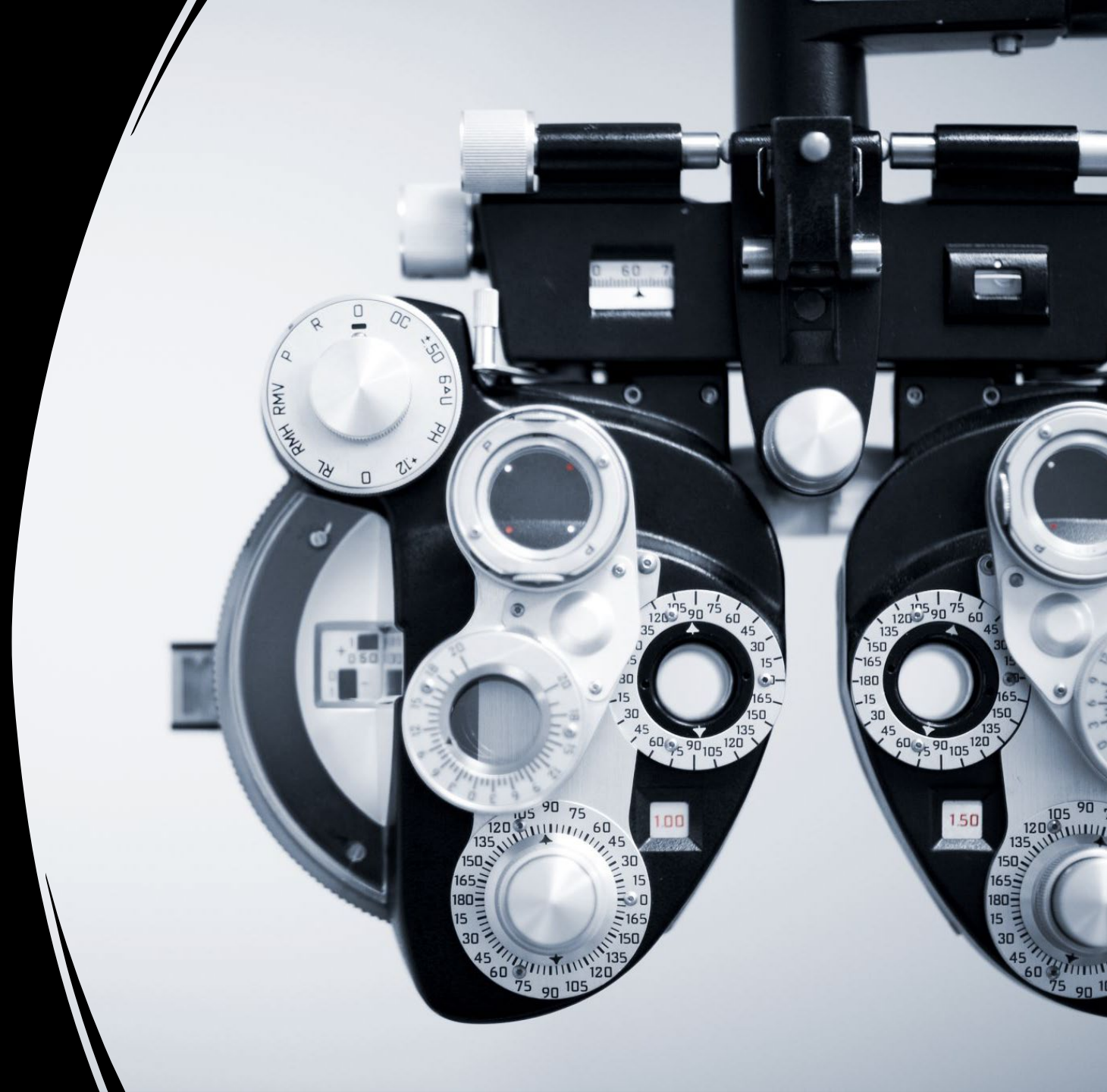
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Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
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VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

DVA Lab

- Dynamic Visual Acuity Test
 - Test of gaze stability while head is moving
- Indicator of the function of the VOR
- Snellen eye chart and metronome at 240 bpm
- Abnormal = VOR impaired
 - 3 or more line loss from static exam



Vestibular Treatment Lab

VOR x 1

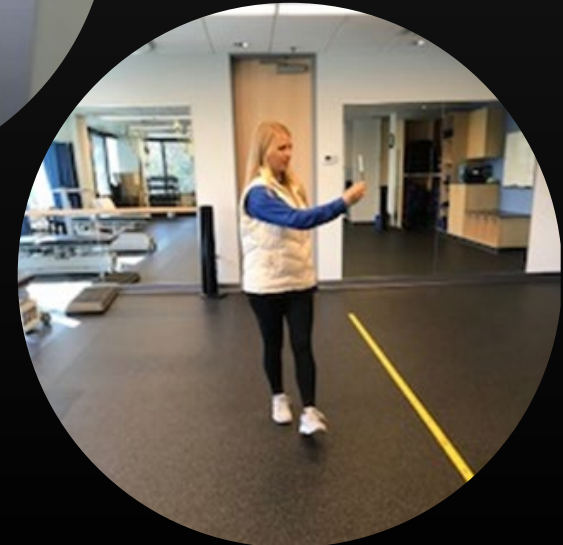
- Sitting, standing, walking, running
- Background
 - low stimulation/calm
 - high complexity/contrast/distracting
- Duration
 - 10 seconds
 - 30 seconds
 - 60 seconds
 - 120 seconds
- Speed (can use a metronome)
 - 120 bpm
 - 180 bpm
 - 240 bpm



Vestibular Treatment Lab

VOR cancellation

- Sitting, standing, walking, running
- Background
 - low stimulation/calm
 - high complexity/contrast/distracting
- Duration
 - 10 seconds
 - 30 seconds
 - 60 seconds
 - 120 seconds
- Speed (can use a metronome)
 - 120 bpm
 - 180 bpm
 - 240 bpm



Vestibular Treatment Case Examples

VOR x 1

- Standing
- 45 seconds
- 4 point increase in dizziness

VOR cancellation

- Walking
- 30 seconds
- Calm environment
- No increase symptoms

VOR x 1

- Sitting
- 30 seconds
- metronome at 140 bpm
- Calm environment
- increases dizziness from 0 to 2/10.

VOR cancellation

- Standing
- 60 seconds
- busy environment
- Increases from 0 to 5/10 dizziness

Vestibular Treatment Case Examples

Case

Case 1

- VOR x 1 for 45 seconds
- Sitting
- Busy training room
- 160 bpm
- 5 point increase in dizziness

Case

Case 2

- VOR cancellation
- Standing
- 60 seconds
- 1 point increase in dizziness

Case

Case 3

- VOR x 1 for 30 seconds
- Walking
- Blank wall
- Metronome at 180 bpm
- 1/10 dizziness

Case

Case 4

- Athlete having a hard time with current HEP
- Over the past 2 days, he has reported room spinning dizziness with bending down, turning head to left, and rolling over in bed

Case

Case 5

- VOR cancellation for 60 seconds
- Metronome at 55 bpm
- Busy environment
- 5 point increase in dizziness



Ocular Treatment Lab

- Convergence:
 - Pencil push ups
 - Brock string
 - 3 dot card
 - Lifesaver card
- Monocular/Binocular?
- Sitting, standing, walking
- Background
- Duration



Ocular Treatment Lab

- Smooth pursuits
- Saccades
- Accommodation

- Monocular/Binocular?
- Sitting, standing, walking
- Background
- Duration



Ocular Treatment Case Examples

Saccades:

- Testing increased symptoms by 1 level in calm environment

10 pencil push ups

- 1 level increase in symptoms in calm environment
- Pencil push ups with 5-10 second hold in busy environment or brock string

Brock string is "easy"

- no symptom provocation
- 3 dot card

Convergence testing

- created 4 level increase in headache with binocular testing
- Monocular push ups

Ocular Treatment Case Examples

1

Case 1

- Smooth pursuit tracking increased eye strain 1 level in calm environment for 30 seconds

2

Case 2

- 3 dot card is not producing challenge or symptoms in calm environment.

3

Case 3

- Brock string created bad headaches, eye strain.

4

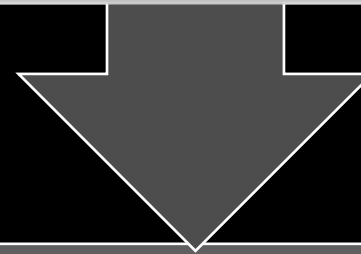
Case 4

- Binocular pencil push ups created a 4 level increase in headache in a calm environment.

Cervical Spine Management

Cervical spine dysfunction often co-exists with concussion

Headaches, dizziness, visual symptoms and nausea



Assessment

Screen for instability/fracture

- Transverse or alar ligament testing
- Midline tenderness to palpation for fracture

Pain

ROM

Strength

Cervical Spine Treatment

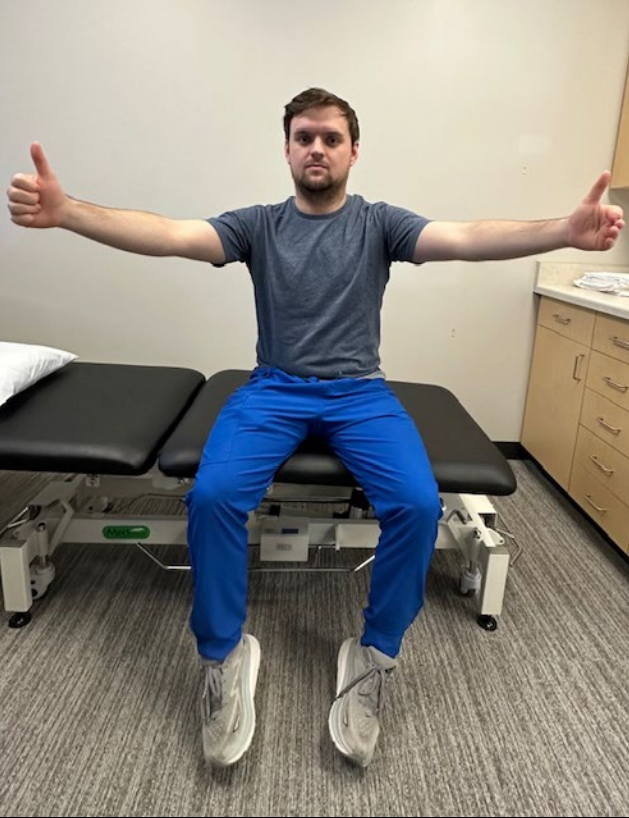
- Acute Phase
 - Decrease inflammation
 - Increase mobility
 - Control pain
- Manual therapy
 - Manual cervical traction
 - Soft tissue work: upper trapezius, levator, suboccipitals, scalenes
 - Graston technique
 - Mobilization
 - CT junction, upper thoracic, mid thoracic, cervical





Cervical Spine

Acute Exercises



Cervical Spine

- Subacute Phase
 - Pain, inflammation and mobility have improved
 - Progress strengthening and cervical proprioception
 - Sport specific exercises

Exertion Therapy



Historically....

Patients with
concussion were
encouraged to
strictly rest

Symptoms should
resolve with time



Exertion



There is insufficient evidence that complete rest is beneficial to recovery of concussion.



“Relative (not strict) rest, which includes ADLs and reduced screen time, is indicated immediately and for up to the first 2 days after injury.”



After a short period of rest during the acute phase of injury (1-2 days), patients should gradually and progressively become more active.



“Prolonged rest, especially in athletes, can lead to physical deconditioning, metabolic disturbances, and secondary symptoms such as fatigue and reactive depression.”

Association Between Early Participation in Physical Activity Following Concussion and Persistent Post-concussive Symptoms in Children and Adolescents

Objective: look at relationship between **physical activity within 7 days** post concussion and occurrence of persistent post concussive symptoms.

Design: prospective, multi center cohort study from 2013 – 2015

- Over 3000 children/adolescents
- Age 5 – 18

Those who participated in physical activity within 7 days post injury vs. no physical activity had a reduced risk of persistent post concussion syndrome at 28 days post injury.

Concussion in Sports: Postconcussive Activity Levels, Symptoms, and Neurocognitive Performance

Design: retrospective cohort study

Participants: 95 student athletes, age 15 +/- 1.35 years

Results: Symptoms and Neurocognitive performance was affected by post concussive activity levels

Conclusion: Athletes engaging in high levels of activity after concussion demonstrated worse neurocognitive performance

- Athletes engaging in moderate levels of activity had the best performance

Benefits of Exercise: General

- Favorable effects on brain neuroplasticity
- Improved neuronal functioning
- Aerobic exercise is cognitively protective
 - Associated with greater levels of BDNF
- Promotes conditioning of cardiovascular system
- Mood/overall well being improvement



Buffalo Concussion Treadmill Test

- Standardized Treadmill Assessment used to investigate exercise intolerance: (Leddy, 2011)
 - 3.6 mph, increase incline by 1% every min for the remaining test.
 - Monitor for DBP / SBP / HR / Rate of perceived exertion
 - Goal: to see if patient can exercise to their max exertion level without symptom onset
 - test should be stopped if:
 - symptoms increase more than 3 points from baseline headache or dizziness
 - new symptom appears
 - (one point for each)
 - Good Inter-rater reliability and sufficient retest reliability for identifying patients with symptom exacerbation from concussion



Buffalo Concussion Treadmill Test

- “Exercise is Medicine” John Leddy
- If patient has symptoms with increasing cardiovascular activity
- Prescribe sub threshold exercise
 - Patient at 80-90% of achieved heart rate at the point of symptom exacerbation (from BCTT)
 - 20 min/day at this heart rate
 - Stop at symptom exacerbation or at 30 minutes
 - 6-7 days per week
 - Increase heart rate 5-10 bpm every 1-2 weeks



Buffalo Concussion Bike Test

- Alternative test to patients with:
 - Orthopedic injuries
 - Significant vestibular sensitivities
 - Small legs! (younger population)



Exertion - Step Wise Return to Play



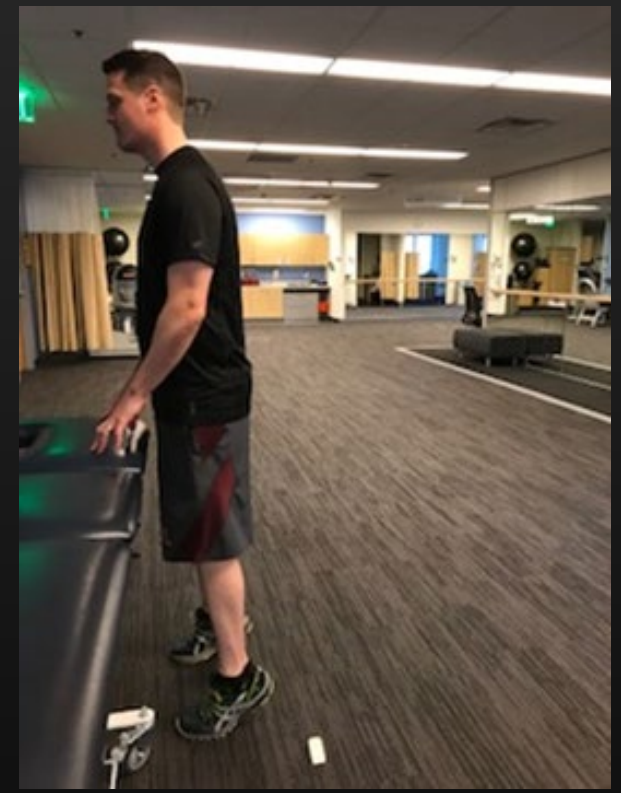
- **Step 1** – Daily activities that do not provoke symptoms
 - Gradual reintroduction of work/school activities
 - Walking, stretching
- **Step 2** – Light to moderate, non-risk physical activity in safe, quiet environment
 - Low resistance exercises
 - Limited head movement and position change
 - Stationary biking
 - Body weight exercises: planks, squats, lunges, wall sits
- **Step 3** – Moderate to heavy, non-risk physical activity, busier environment
 - Treadmill/elliptical jogging, and running
 - Sit-ups, push-ups, burpees, mountain climbers
 - Independent non-contact sport specific activities
 - shooting hoops, soccer foot drills, playing catch, independent skating)
- **Step 4** – Heavy, non risk physical activity, busy environment
 - Dynamic position changes in complex environment
 - weight lifting
 - Interval training
 - Non contact practice
- **Step 5** – Heavy exertion and sport specific activities in complex environments
 - Participation in contact drills and contact practice
- **Step 6** – Game
 - Any symptoms would be abnormal. Athlete should discontinue play and return for reevaluation.

Exertion - Step Wise Return to Play

- Each step requires at least 24 hours without symptoms
- 6 steps total
- Generally, the athlete would take about 1 week to progress through step wise protocol once they are asymptomatic at rest.
- Athletes should not progress to the next level if they experience symptoms on any level.
 - For example, if symptoms are experienced on step 3, the athlete should drop down to step 2 and try to progress again after 24 hours.
 - This may require an athlete to participate in the same exercise level several days in a row.



Basketball Exertion Example - Step 1



Basketball Exertion Example - Step 2



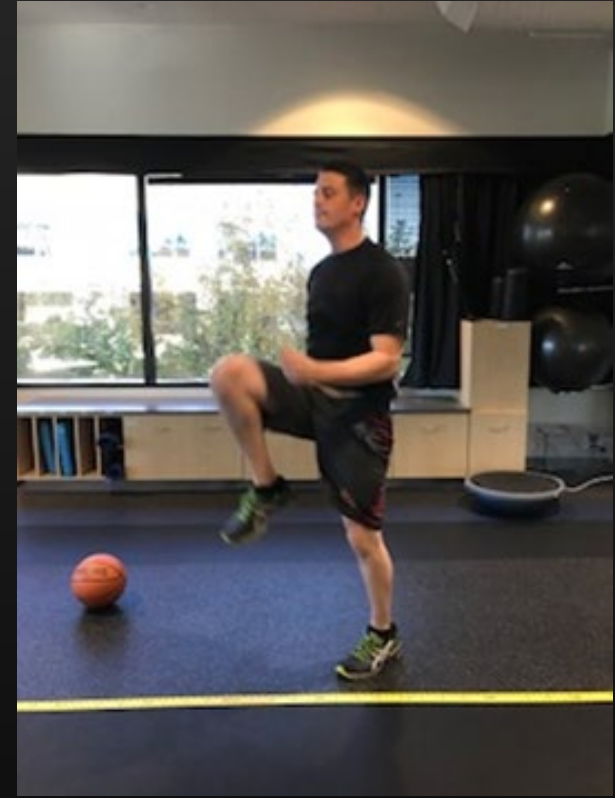
Basketball Exertion Example - Step 2

Basketball Exertion Example - Step 3





Basketball Exertion Example - Step 3



Basketball Exertion Example - Step 4



Basketball Exertion Example - Step 4



Basketball Exertion Example - Step 5



Basketball Exertion Example - Step 5



Team work: Exercise Treatment Progression

- 16 year old baseball player
- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5



Team work: Exertion Treatment Progression

- 21 year old basketball player
- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5

Case Studies



Case 1 – Hockey Player

17 year old Hockey Player who sustained a concussion during a hockey game

Presented to Physical Therapy 3 months after sustaining his 4th lifetime concussion

Lived 6 hours away in small town

Patient and family very concerned with status

Case 1 – Hockey Player

- **Subjective:**
- Received several months of physical therapy near home for ongoing symptoms after his previous concussions and denied full recovery
- Symptoms:
 - Headache
 - Neck Pain
 - Difficulty concentrating and reading
 - Environmental sensitivities (sensitivity to light, sound, busy environments)
 - Depressed mood
 - Sleep disruption
 - Pt was sleeping 1 -2 hours per night

Case 1 – Hockey Player

- Patient had not returned to school since his last injury due to symptom provocation
- Since injury, patient started medications for depression, sleep, and headaches, but reported no change in symptoms

Case 1 – Hockey Player

- Evaluation

- ImPACT neurocognitive testing scores well below baseline
- Vestibular exam
 - VOR x 1 and VOR cancellation testing provoked headache and dizziness
- Ocular motor exam
 - Smooth pursuits, saccades and convergence testing produced headache
- Exertion testing
 - Buffalo Concussion Treadmill test increased headache and dizziness
- Upper quarter musculoskeletal examination
 - Weakness in deep neck flexors and middle/lower trapezius
 - Forward head and shoulder posture
 - Thoracic spine hypomobility

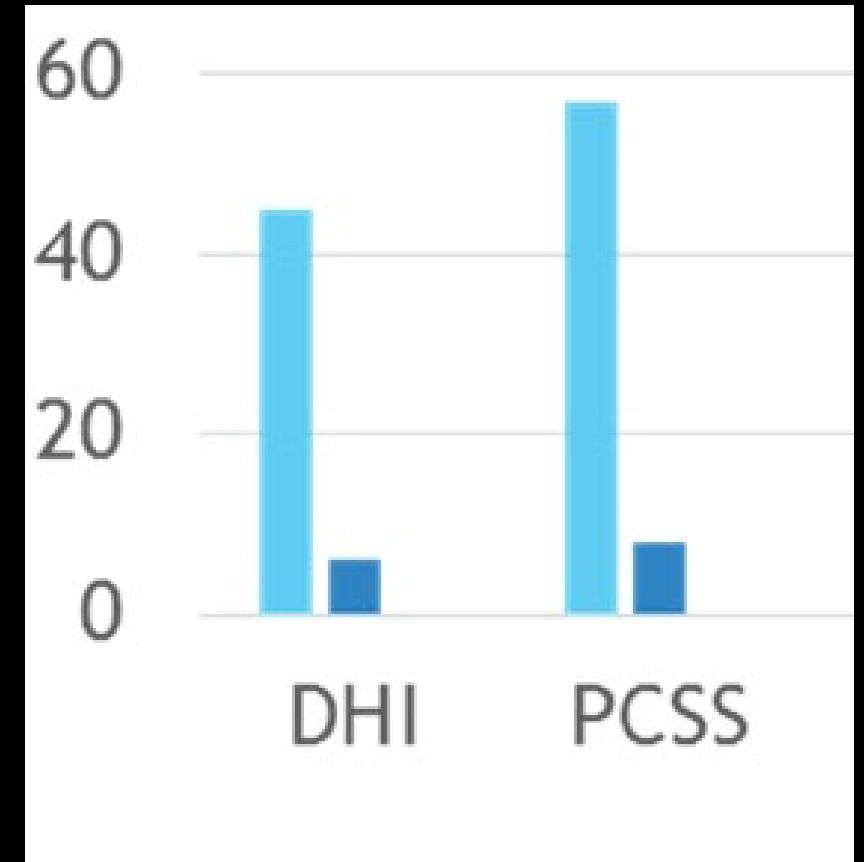
Case 1- Hockey Player

- **Treatment** 4 visits over 6 week period, with home exercise program progressions

Type of exercise	Purpose
Oculomotor exercises	Decrease sensitivity of the ocular motor system
Vestibular therapy	Habituation, adaptation, and tolerance
Postural re-education and scapular stabilization	Decrease cervical pain
Cardiovascular training	Increase tolerance to aerobic activity

Case 1 – Hockey Player

- Outcome
- Titrated off all medications
- Returned to full days of school with asymptomatic status
- Participated in baseball practice (hockey season was over)
- Patient reports of mood, sleep, and cognitive function were congruent with initial preinjury baseline
- Improved PCSS and DHI
- ImPACT scores were back to baseline
- Ocular motor, vestibular, and exertion testing were symptom free and within normal limits
- Neck pain resolved



Case 1 - Hockey Player

- **Discussion**
- Physical therapy is an important part of comprehensive management for post concussion syndrome and prolonged recovery.
- Physical therapy can treat a wide range of debilitating subjective and objective impairments.
- Successful physical therapy management in this case study utilized a multi-modal approach consisting of patient education and supervised progression through:
 - Vestibular therapy
 - Ocular motor tolerance training
 - Exertion training
 - Cervical rehabilitation

Case 2 – Soccer Player

Patient was a 13 year old female soccer and hockey player

Presented to physical therapy 4 weeks after sustaining her second lifetime concussion during soccer practice

Patient and mother concerned with status

Case 2 – Soccer Player

- Please put together a list of subjective questions

Case 2 – Soccer Player

- **Subjective:**
- Symptoms included:
 - Headache
 - Dizziness
 - Sensitivity to environmental stimuli (light, sound, and busy environments)
 - Difficulty concentrating and reading
 - Mental fogginess

Case 2 – Soccer Player

Now let's put together
a list of objective
measures you would
like to assess.

What would you like
to test and why?

Case 2 – Soccer Player

Evaluation

- ImPACT neurocognitive testing scores well below average (impaired)
- Vestibular exam
 - VOR x 1 and VOR cancellation testing provoked headache and dizziness
- Ocular motor exam
 - Smooth pursuits, saccades and convergence testing produced headache
- Exertion testing
 - Buffalo Concussion Treadmill test produced nausea

Case 2 - Questions

- Physical Therapy:
 - What vestibular impairments would you focus on?
 - How would you measure vestibular function for this patient?
 - Is this patient appropriate for exertion? Explain
 - Describe the vestibular treatment progression for this individual.
 - Describe the cervical management for this patient.
 - What measures would you look at to clear this individual to RTP?
 - Does this patient have any factors that predispose him to a protracted recovery?

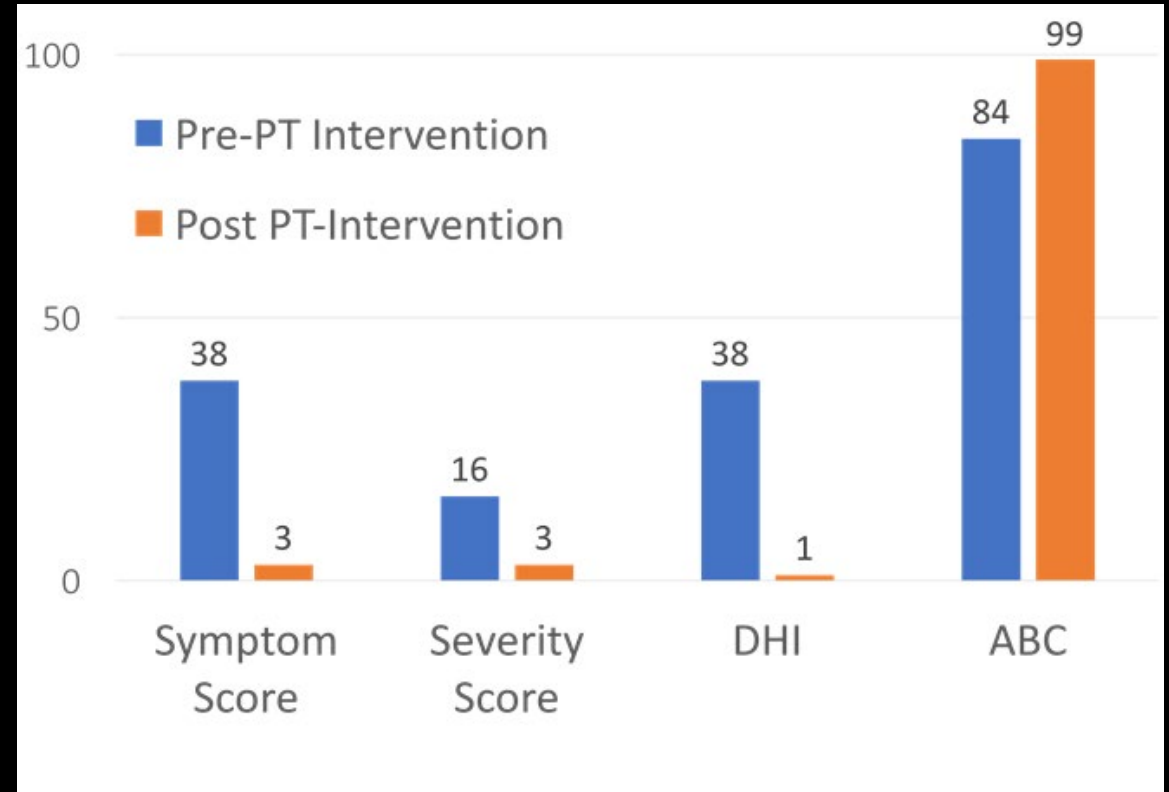
Case 2 – Soccer Player

Treatment: Patient was seen for 4 visits over a 5 week period

- Sport specific exercises were applied through a progression of intensity and integration of vestibular and ocular motor systems using vertical, horizontal, and rotational changes.

Case 2 – Soccer Player

- **Outcome:**
- Asymptomatic with classroom and school activities
- ImPACT scores returned to predicted baseline levels
- Vestibular and Ocular motor examination was symptom free and within normal limits
- No symptoms with cardiovascular exertion
- Returned to soccer practice and then games



Case 2 – Soccer Player

- **Discussion**
- Case study emphasizes a multi-modal approach to concussion rehabilitation consisting of:
 - vestibular-ocular motor training
 - physiologic conditioning
 - sport specific exertion therapy

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Image Citations

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Brain picture: <https://www.etsy.com/listing/1515884947>

Money: <https://www.freepik.com/free-photos-vectors/money-pack>

Hospital picture: <https://www.freepik.com/free-photos-vectors/hospital>

Doctor: <https://www.freepik.com/free-photos-vectors/doctor>

Football: <https://www.freepik.com/free-photos-vectors/football>

Accommodation: [Accommodation of Eye- Definition and Process | AccuVision](#)